

We claim:

1. An apparatus for cooling filaments in a filament forming process comprising:

a first nozzle located at a first position, said first nozzle directing a first fluid at the filaments; and

a second nozzle located at a second position, said second nozzle directing a second fluid at the filaments, wherein said first fluid is different from said second fluid, and said first nozzle and said second nozzle are positioned to direct said first fluid and said second fluid at the filaments upstream of a size applicator in the filament forming process.

2. The apparatus of claim 1, wherein the filaments are attenuated from a bottom plate of a bushing, and said first position is closer to the bottom plate than said second position.

3. The apparatus of claim 1, wherein said first fluid is air and said second fluid is water.

4. The apparatus of claim 1, wherein said second fluid is a mixture of air and water.

5. The apparatus of claim 4, wherein said second nozzle is an air-atomizing nozzle.

6. The apparatus of claim 3, further comprising:

a first manifold, said first nozzle being coupled to said first manifold; and

a second manifold, said second nozzle being coupled to said second manifold, wherein air is conveyed in said first manifold and water is conveyed in said second manifold.

7. An apparatus for cooling filaments in a filament forming process, the filaments attenuated from a bottom plate of a bushing, the filaments subsequently contacting a size applicator, the apparatus comprising:

a first nozzle disposed to direct a first fluid at the filaments, said fluid being a mixture of water and air.

8. The apparatus of claim 7, further comprising:

a second nozzle located at a second position, said second nozzle directing a second fluid at the filaments, wherein said first fluid is different from said second fluid.

9. The apparatus of claim 8, wherein said second fluid is air.

10. The apparatus of claim 9, wherein said second position is located upstream of said first position along the direction in which the filaments are attenuated.

11. The apparatus of claim 10, further comprising:

a first manifold coupled to said first nozzle; and

a second manifold coupled to said first nozzle, wherein air is conveyed in said first manifold and water is conveyed in said second manifold.

12. The apparatus of claim 7, further comprising:

a bushing having a generally planar bottom plate; and

a size applicator.

13. The apparatus of claim 12, wherein said first nozzle is directed toward a filament forming region between said bottom plate and said size applicator and in a direction downstream along the filaments relative to a plane parallel to said bushing bottom plate.

14. The apparatus of claim 13, wherein said first nozzle is oriented at an angle relative said plane, the angle being in the range of 0 to 35 degrees.

15. A method of forming continuous filaments, the filaments being attenuated from a bottom plate of a bushing in an attenuation direction, the filaments subsequently contacting a size applicator, the method comprising the steps of:

5 directing a first fluid at the filaments from a first nozzle located at a first position; and

directing a second fluid at the filaments from a second nozzle located at a second position, wherein the first position and the second position are located between the bushing and the size applicator along the attenuation direction, and the first fluid and the second fluid are different fluids.

16. The method of claim 15, wherein said first position is closer to the bottom plate than said second position.

17. The method of claim 16, wherein said first fluid is air.

18. The method of claim 17, wherein said second fluid is water.

19. The method of claim 16, wherein said second fluid is a mixture of air and water.

20. The method of claim 15, wherein said directing a first fluid includes directing said first fluid with a plurality of nozzles, each of said nozzles directing said first fluid at a different flow rate.

21. A method of cooling filaments attenuated from the bottom plate of a bushing and drawn through a filament cooling region into contact with a size applicator, the method comprising:

30 atomizing water with pressurized air; and

directing a flow of said atomized water into the filament cooling region with a pressure and at a flow rate sufficient to cool filaments in the filament cooling region below a predetermined temperature while maintaining a moisture level on the filaments below a predetermined value.

22. The method of claim 21, wherein the filaments are drawn in the form of a fan, said fan having a front side and a rear side relative to the contact point of the filaments on the size applicator, said front side corresponding to the side of the size applicator which the filaments contact, said directing a flow of said atomized water including directing said flow from said front side to said rear side.

23. The method of claim 21, wherein said directing a flow of said atomized water includes directing said flow of atomized water with a plurality of nozzles, each of said nozzles directing said flow of atomized water at a different flow rate.

24. A method of cooling filaments attenuated from the bottom plate of a bushing and drawn through a filament cooling region into contact with a size applicator, the method comprising:

directing a flow of air into a first cooling region through which the filaments are drawn;

directing a spray of water into a second cooling region through which the filaments are drawn, said second cooling region being spaced from said first cooling region.

25. The method of claim 24, wherein said second cooling region is downstream along the filaments from said first cooling region.

26. The method of claim 25, wherein said air and said water are sprayed on the same side of the filaments.

27. The method of claim 24, wherein said directing a flow of air includes directing air with a plurality of nozzles, each of said nozzles directing said air at a different flow rate.